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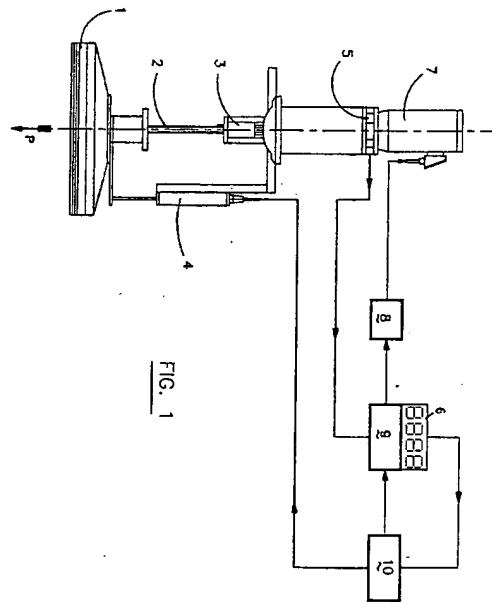
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㉒ **Method of and apparatus for continuously controlling the pressure applied on workpieces in a double-plate lapping machine.**

㉓ **A method of and an apparatus for continuously controlling the pressure applied on workpieces in a double-plate lapping machine, in which the upper plate is connected by means of a linear transducer for controlling the position thereof to a central processing unit driving a servomotor associated to a pressure measuring unit provided with a videodisplay and interconnected between the servomotor and the plate for measuring the pressure applied to the plate, and belonging to a mechanical assembly causing the plate to axially move in both directions so as to continuously adjust the pressure on the workpieces according to data set in the central processing unit and the signals fed by the transducer and the pressure measuring unit.**



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The present invention relates to the field of the superfinishing machines and, more particularly, it concerns a method of and an apparatus for continuously controlling the pressure applied on workpieces in a double-plate lapping machine.

As well known to those skilled in the art, the progressive lightening of the upper plate due to the wear thereof is taken into account as a very important factor in the lapping operations. Such lightening can cause the pressure on the workpieces to vary so as to affect negatively the machining of the workpieces. Of course, this negative circumstance is as much more detrimental to the qualitative effects as higher is the required precision degree of the lapping operation.

Several apparatus have been designed and manufactured aiming at controlling the position of the upper plate with regard to the workpieces in order either to overcome or at least to reduce the above problem.

At the present status of art said known apparatus can be classified in three different ways according to the operating mode thereof.

The first one is a mechanical counterweight system balancing the plate. This system is not accurate because the counterweight is unbalanced as the plate is worn out, and the change in the operating pressure is considerable and cannot be easily controlled.

Another known system makes use of a pneumatic circuit having the function of restoring the worn out plate. Thus the plate is aiming at "floating" so that the pressure is still not uniform.

There is at last a hydraulic device which is somewhat complex due to the presence of valves, unions, thermal sensors and other delicate and expensive components. Apart from the complex construction this hydraulic system is affected by operating problems such as the low speed of response, the necessity of taking up any slack a.s.o., and cannot counterbalance the operating pressure of the plate when the pressure difference is lower than a certain limit value.

This invention seeks to provide a method and an apparatus allowing the position of the plate and then the operating pressure of the same to be continuously controlled even for very small differential pressures of the order of 1 kg corresponding to about 1/100 of the weight of the upper plate.

According to the invention a method of controlling the position of the upper plate in a lapping machine is provided including the step of mechanically driving the plate which is axially shifted under control of a linear transducer connected to said plate and responsive to a central processing unit which is drivingly connected to said axial drive of the plate and to a pressure measuring unit sensing the bearing pressure of the plate and connected between the plate and a servomotor driving said axial shift.

Such mechanical axial drive system includes a micrometrical feeding device formed of a ball bearing

5 screw connected to the plate and a lead nut drivingly connected to said ball bearing screw and driven by the servomotor when the transducer feeds a control signal which is compared with the setting data measured by the pressure measuring unit and fed to the central processing unit. The pressure measuring unit displays the measured values on a digital display.

10 This invention will now be described with reference to the accompanying drawings showing as an illustrative and non-limitative example a preferred embodiment of the invention. In the drawing:

15 Fig. 1 shows the general operating diagram of the method according to the invention;

Fig. 2 shows the mechanical feeding device of the plate in axial section;

Fig. 3 is a particular of the device of Fig. 2 in enlarged scale showing the draft peg integral with a ball bearing screw.

20 With reference to Fig. 1, the upper plate of the lapping machine is designated by 1. Such plate rotates about its axis to carry out a lapping operation in cooperation with the lower plate not shown because it is not a part of the present invention. Besides the rotary motion plate 1 can axially move to apply the lapping pressure P (decanewton) to the workpieces. Such axial shift is carried out by means of a micrometrical mechanical drive by a ball bearing screw 2 engaged in the lead nut 3. The latter is carried by the stationary frame 4A of the lapping machine and is rotated by an electronic switching brushless servomotor 7 as better described afterwards.

25 The pressure measuring unit 5 is interconnected between servomotor 7 and lead nut 3 and will not be described as it is well known.

30 The controlling method is as follows:

35 Working parameters, among which pressure P and height H of the workpiece, are set in the central processing unit 10 which may be a PLC/microprocessor. Parameter signals are amplified by the proportional integral differential (P.I.D.) amplifier designated by 9 and fed through the control power supply 8 to servomotor 7 driving plate 1 to move downwards by the system formed of screw 2 and lead nut 3 which will be described in detail below.

40 The position of plate 1 with respect to the workpieces is detected by the linear transducer 4. As plate 1 engages the workpieces, the pressure measuring unit senses the pressure value and shows it on video-display 6, feeding also such data to block 10 to automatically adjust the pressure.

45 In Figs. 2 and 3 the mechanical control device for axially driving plate 1 is shown in detail.

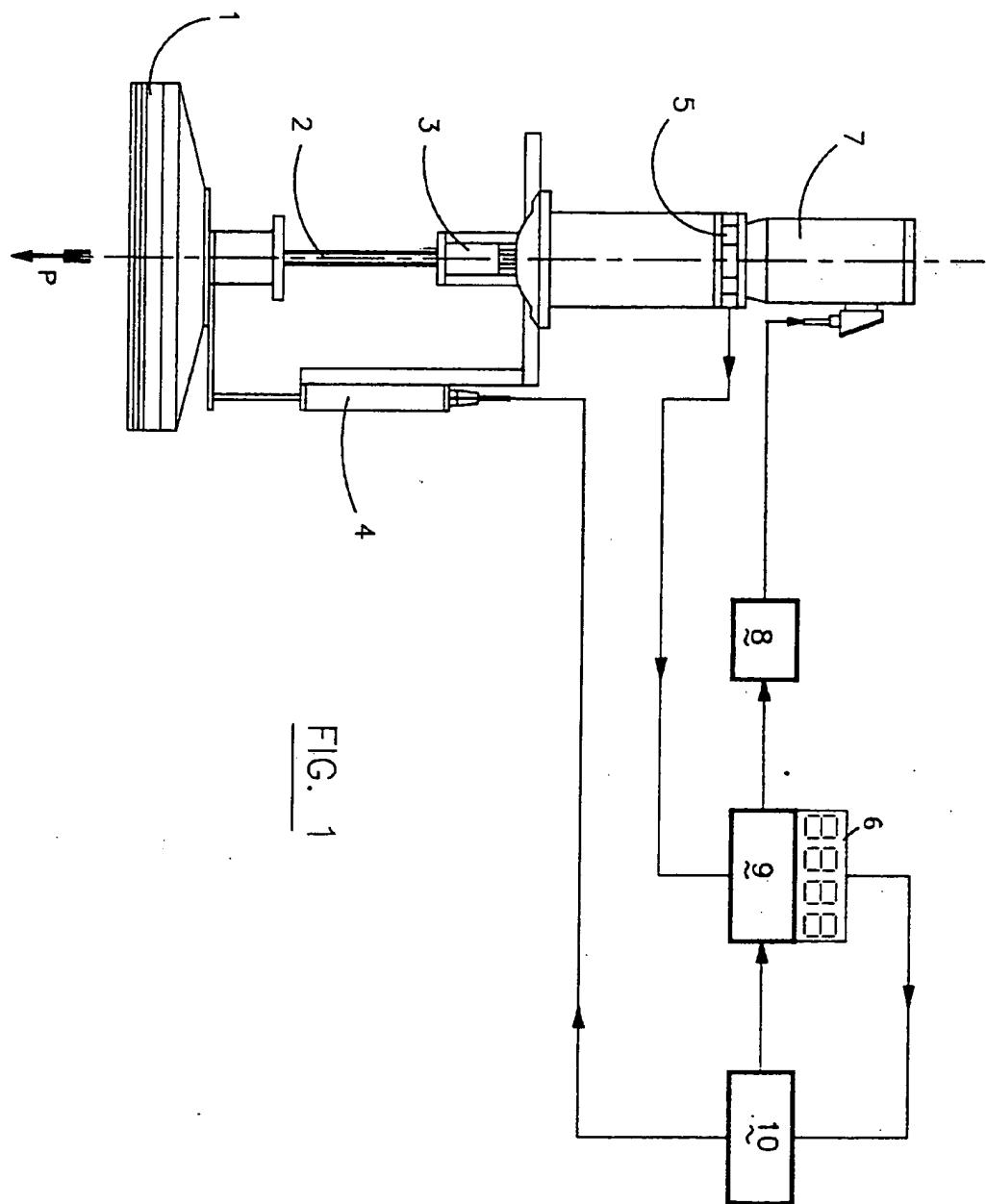
50 Above and concentrically to the pressure measuring unit 5 servomotor 7 carries the drive shaft 11 connected through key 12 to the hollow shaft 13, in which two elongated, diametrically opposed slots are formed. Pins 15 carried by the draft peg integral with ball bearing screw 2 connected to lead nut 3 already described

in Fig. 1 slide into said slots. The rotation of hollow shaft 13 causes correspondingly ball bearing screw 2 and lead nut 3 to rotate, the latter in turn causing shaft 18 carrying at its lower end plate 1 to axially move. At the same time plate 1 is rotated about geometric axis H of shaft 18 by a drive belt 19 engaging pulley 20 integral with the rotating column 21 within bellow 23 mounted between case 22 and plate 1.

The present invention has been illustrated and described according to a preferred embodiment thereof, however, it should be understood that operative and/or constructive modifications may be made by those skilled in the art without departing from the scope of the present industrial invention.

### Claims

1. A method of controlling the pressure of the upper plate in a lapping machine, characterized in that it includes the steps of mechanically controlling by means of a micrometrical assembly the lowering of the plate under control of a linear transducer connected to said plate and associated to a central processing unit drivingly connected to said mechanical lowering assembly. 20
2. The method of claim 1, characterized in that said mechanical micrometrical device is driven by an electronic switching servomotor through a pressure measuring unit which continuously measures the pressure on the workpieces. 30
3. The method of claims 1 and 2, characterized in that the plate pressure measured by said pressure measuring unit is constantly compared with data set in the central processing unit and with the signal fed by said transducer so as to adjust the pressure every moment. 35
4. The method of claims 1 to 3, characterized in that said mechanical lowering assembly includes a hollow shaft keyed on the shaft of said servomotor and carrying a pair of elongated, diametrically opposed slots in which two pins rotatably mounted at the ends of a draft peg integral with a ball bearing screw are sliding. 45
5. The method of claims 1 to 4, characterized in that said ball bearing screw is associated to a lead nut causing a shaft coaxial with said screw and connected to the plate to slide. 50
6. The method of claims 1 to 5, characterized in that said pressure measuring unit is provided with a digital display and is connected to the central processing unit. 55



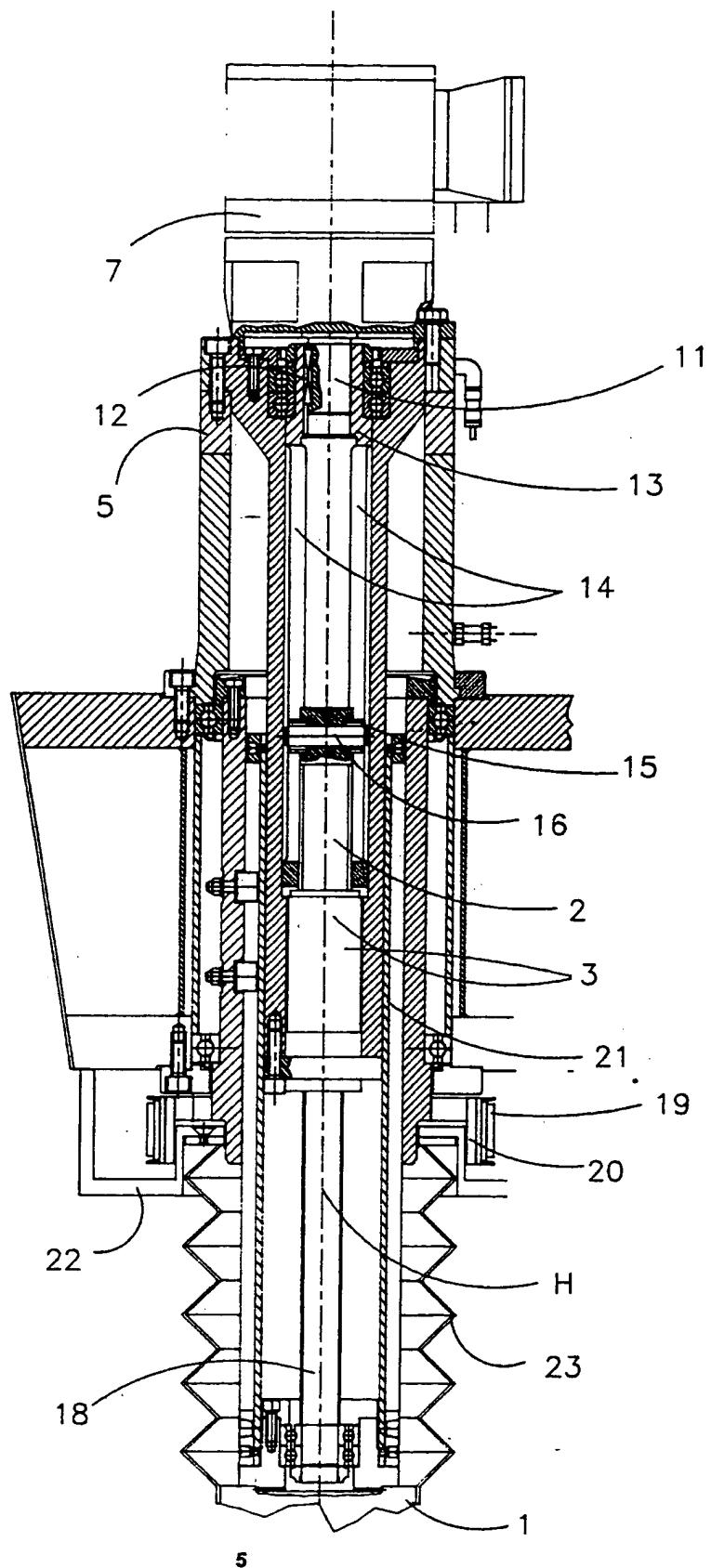


FIG. 2

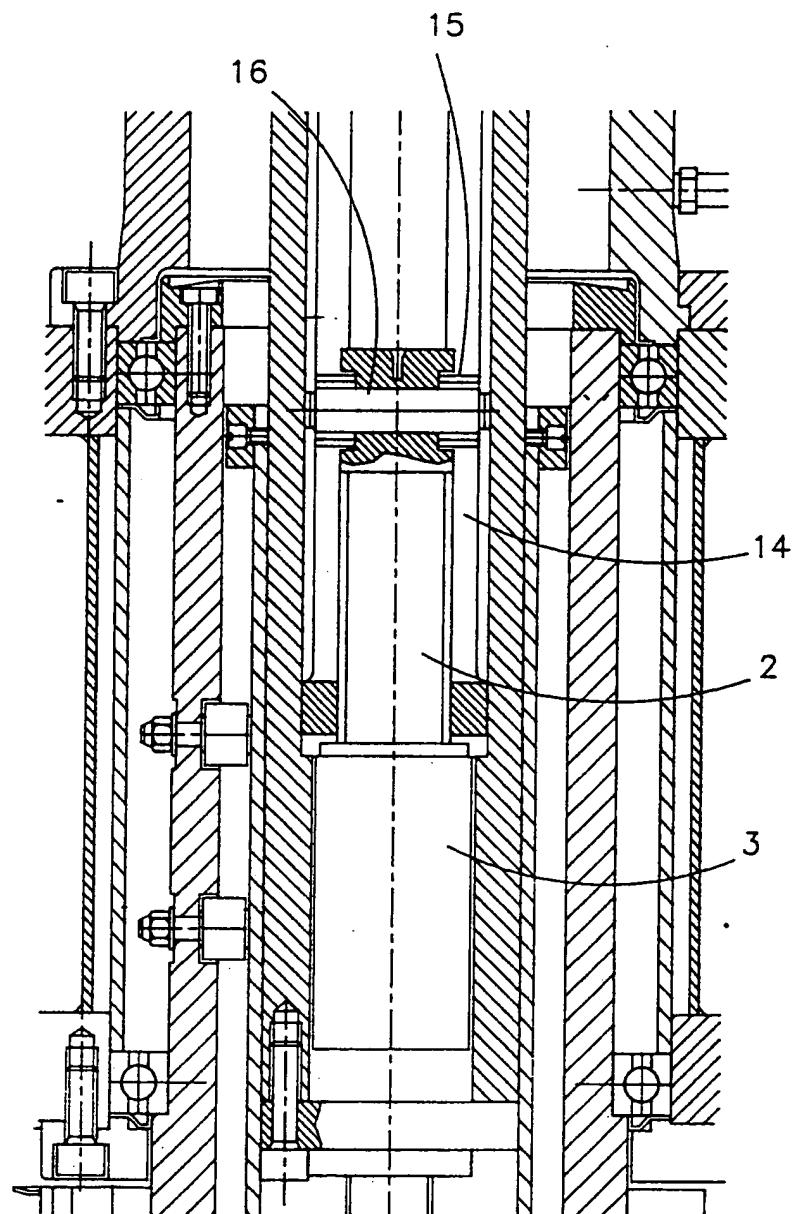


FIG. 3